

## Effect of enrichment on broiler leg health

Table 3 Summary of research on the effect of stocking density on leg health in broilers (page 1 of 2)

Study	Population Age Sex Breed	Group size (N) <sup>1/</sup> replications per treatment	High stocking density (Comparator)	Low stocking density (Exposure)	Outcome and the effect of exposure indicated as (↓) <sup>2</sup> ,(↑) <sup>3</sup> or (0) <sup>4</sup> .
Seet & Azizah 1990	1 day to 8 weeks Mixed Hubbard	100 to 150 /3	0.07 m2/bird	1) 0.09 m2/bird 2) 0.11 m2/bird	Occurrence of leg weakness (0)
Sorensen <i>et al</i> 2000	1 day to 49 days Mixed Ross 208	Experiment 1: 120/3 Experiment 2: 275/8	Experiment 1: 435 cm2/bird Experiment 2: 455 cm2/bird	Experiment 1: 1) 625 cm2/bird 2) 833 cm2/bird Experiment 2: 625 cm2/bird	Experiment 1: Gait score (↓) Experiment 2: Gait score (↓) TD score (0) Prevalence of hock and footpad burns (↓) Valgus and varus (0) Curvature of tibia (0)
Hall 2001	1 day to 40 days Mixed Ross 508 and Ross PM3	12600 to 17000/4	40kg/m2	34kg/m2	Culled due to leg problems (↓) Prevalence of hock burn (↓) Prevalence of leg bruises (0) Prevalence of leg breakage (0)
McLean <i>et al</i> 2002	1 day to 6 weeks Mixed Ross 308	130 to 208 /4	40 kg/m2	1) 34 kg/m2 2) 28 kg/m2	Contact dermatitis score of hock and foot (0) Gait score (0)
Tablante <i>et al</i> 2003	1 day to 42 days Mixed Avian	45 to 90/3	20 birds/m2	1) 15 birds/m2 2) 10 birds/m2	TD prevalence (0) Bone ash of tibiotarsus (0)
Thomas <i>et al</i> 2004	1 day - 5 weeks Males Not stated	13 to 50/6	20 birds/m2	1) 5 birds/m2 2) 15 birds/m2 3) 10 birds/m2	Footpad and hock burn score (↓) Gait score (↓)
Dozier <i>et al</i> 2006	1 day to 36 days Males Ross x Ross 708	75 to 120/8	40 kg/m2	1) 35 kg/m2 2) 30 kg/m2 3) 25 kg/m2	Footpad score (↓) Gait score (0)
Ravindran <i>et al</i> 2006	1 day to 35 days Males Ross	42-62/4	24 birds/m2	1) 20 birds/m2 2) 16 birds/m2	Footpad and hock burn score (0) Gait score (0)
Meluzzi <i>et al</i> 2008	1 day to 49 days Males Ross 508	66 to 84/8	14 birds/m2	11 birds/m2	Incidence of hock burns (↓)
Buijs <i>et al</i> 2009	1 day to 39 days Mixed Ross 308	8 to 72/4	1) 56 kg/m2 2) 47 kg/m2 3) 41 kg/m2 4) 35 kg/m2	1) 33 kg/m2 2) 23 kg/m2 3) 15 kg/m2 4) 6 kg/m2	LTL test (↑) Footpad and hock dermatitis score (↓)
Skrbic <i>et al</i> 2009	1 day to 42 days Mixed Hubbard	77 to 123/5	16 birds/m2	1) 13 birds/m2 2) 10 birds/m2	Gait score (0) Hock burn lesion score (0) Footpad lesion score (0)

1. Group size varies according to density

2. (↓) Low stocking density resulted in a significant decrease in the outcome. For all outcomes, except LTL, a decrease in the outcome signifies a positive effect of low stocking density on leg health.

3. (↑) Low stocking density resulted in a significant increase in the outcome.

4. (0) Low stocking density had no significant effect on the outcome.

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Table 4 Summary of research on the effect of light program on leg health in broiler chickens (page 1 of 3)

Study	Population Age Sex Breed	Group size (N)/ replications per treatment	Continuous light schedule (Comparator)	Dark/light schedule (Exposure)	Outcome and the effect of exposure indicated as (↓) <sup>1</sup> ,(↑) <sup>2</sup> or (0) <sup>3</sup> .
Robbins <i>et al</i> 1984	1 day to 8 weeks Mixed Hubbard x White mountain	15/5	24L	16L:8D	Incidence of leg disorders (↓)
Wilson <i>et al</i> 1984	1 day to 49 days Males Not stated	3 experiments each using a total of 2400/not stated	Continuous lighting	1L:2D	Incidence of leg abnormalities (↓) Gait score (↓)
Ketelaars <i>et al</i> 1986	1 day to 6 weeks Mixed Not stated	Total of 960/2	23L:1D	1L:3D	Incidence of leg abnormalities (↓)
Classen & Riddell 1989	1 day to 42 days Mixed Not stated	Experiment 1: 300/2 Experiment 2: 600/2 Experiment 3: Total of 5616/3	23L:1D	1) 6L:18D (Day 1-14), 23L: 1D (Day 21-42) 2) Gradual increase 6L → 23L	Incidence of leg abnormalities (↓)
Classen <i>et al</i> 1991	1 day to 42 days Mixed Not stated	Total of 5616/3	23L:1D	1) Gradual increase 6L → 23L 2) Gradual increase 6L → 23L with 1L midway through the scotoperiod	Incidence of leg abnormalities (↓)
Renden <i>et al</i> 1991	1 day to 56 days Males Ross x Cobb	100/4	23L:1D	1) 1L:3D 2) 6L:18D (Day 1-14) 1L:3D (Day 15-56) 3) 6L:18D (Day 1-14); 23L:1D (Day 15-56)	TD score (0) Prevalence of leg problems (↓) <sup>4</sup>
Renden <i>et al</i> 1992	1 day - 42 days Males Peterson x Arbor Acres and Ross x Arbor Acres	50/4	23L:1D	6L:18D (Day 1-14), 1L:3D (Day 15-56)	Culled due to leg problems (↓) Prevalence of leg disorders (↓) TD score (↓)
Blair <i>et al</i> 1993	1 day to 42 days Males Peterson x Arbor Acres	150/4	23L:1D	Gradual increase 6L → 23L	Incidence of valgus twisting (0) Incidence of varus twisting (↓) Ability to jump (↑)
Wong-Valle <i>et al</i> 1993	Experiment 1: 1 day to 7 weeks Mixed Not stated Experiment 2: 1 day to 7 weeks Males Not stated	Experiment 1: 126/4 Experiment 2: 150/4	23L:1D	1L:3D	Incidence of TD (0)

Abbreviations: L=hours of light, D=hours of darkness

1. (↓) A dark/light schedule resulted in a significant decrease in the outcome. For all outcomes, except ability to jump on platform, a decrease in the outcome signifies a positive effect of a dark/light schedule on leg health.

2. (↑) A dark/light schedule resulted in an increase in the outcome.

3. (0) A dark/light schedule had no significant effect on the outcome.

4. The 23L:1D light program increases prevalence of leg problems only when comparing to light program 2. When comparing 23L:1D to light program 1 and 3 there is no difference in prevalence of leg problems.

5. The 23L:1D light program increases gait scores only when comparing to light program 2. When comparing 23L:1D to light program 1 there is no difference.

## Effect of enrichment on broiler leg health

Table 4 Summary of research on the effect of light program on leg health in broiler chickens (page 2 of 3)

Study	Population Age Sex Breed	Group size (N)/ replications per treatment	Continuous light schedule (Comparator)	Dark/light schedule (Exposure)	Outcome and the effect of exposure indicated as (↓) <sup>1</sup> ,(↑) <sup>2</sup> or (0) <sup>3</sup> .
Leterrier and Constantin 1996	1 day to 42 days Males IJV915	205/not stated	23L:1D	Photoperiod gradually decrease (day 1-8), gradually increase (day 9- 42)	Prevalence of valgus-varus deformities (↓) Occurrence of crooked toes (↓)
Renden <i>et al</i> 1996	Experiment 1: 1 day to 49 days Males Ross 208 Experiment 2: 1 day to 42 days Males Ross 208	50/4	23L:1D	Experiment 1: 1) 16L:8D 2) 16L:3D:1L:4D 3) 16L:2D:1L:2D:1L:2D Experiment 2: 1) 16L:2D:1L:2D:1L:2D 2) Gradual increase in light, simple 3) Gradual increase in light, complex	Experiment 1: Prevalence of leg problems (↓) Prevalence of TD (0) Experiment 2: Prevalence of leg problems (0) Prevalence of TD (0)
Sorensen <i>et al</i> 1999	1 day to 44 days Mixed Ross 208	Experiment 1: not relevant Experiment 2: 500/4 Experiment 3: 350/6 Experiment 4: 30/48	Experiment 2: 23L:1D Experiment 3 & 4: 21L:1 D	16L:8D	Experiment 2: Gait score (↓) Experiment 3: Gait score (0) Footpad burn score (↑) Hock burn score (0) Experiment 4: Gait score (0) Experiment 2,3 & 4: TD score (↓) Valgus/varus angulation score (0)
Rozenboim <i>et al</i> 1999	1 day to 49 days Mixed Avian	90/3	23L:1D	1) Increasing day length 2) Intermitted light with increase in total light per day	Percentage of leg condemnation (↑)
Sanotra <i>et al</i> 2002	1 day to 35 days Mixed Ross 208	2 commercial producers: 55000 and 35000 per house/2 replicates per producer	24L	1) Gradual decrease and increase light schedule 2) Instant decrease and increase light schedule	Gait score (↓) <sup>5</sup> TD score (↓)
Siddiqui <i>et al</i> 2003	1 day to 49 days Mixed Vencobb	50/4	23L:1D	2L:4D	Incidence of leg abnormalities (↓) Severity of leg abnormalities measured as walking ability (0) Mortality due to leg disorders (0)
Petek <i>et al</i> 2005	1 day to 6 weeks Males Ross PM3	50/4	24L	12L + (3x(1L:3D))	TD score (0) Diameter of knee joint (0) Length and thickness of tibiotarsus (0)
Onbasilar <i>et al</i> 2007	1 day to 6 weeks Males Ross PM3	20/5	24L	1L:3D	TD score (0)
Brickett <i>et al</i> 2007	1 day to 35 days Males Ross 308	50/not stated	20L:4D	12L:12D	Gait score (↓) Bone ash of tibiotarsus (↓) Length, width and curvature of femur and tibiotarsus (0) Histology of femoral head (0)

Abbreviations: L=hours of light, D=hours of darkness

1. (↓) A dark/light schedule resulted in a significant decrease in the outcome. For all outcomes, except ability to jump on platform, a decrease in the outcome signifies a positive effect of a dark/light schedule on leg health.
2. (↑) A dark/light schedule resulted in an increase in the outcome.
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Yildiz <i>et al</i> 2009	1 day - 6 weeks Mixed Ross PM3	25/4	24L	12L + (3x(1L:3D))	Weight and length of tibiotarsus (↓) TD score (0) Cortical thickness and volume (↓)
Blatchford <i>et al</i> 2012	1 day - 42 days Mixed Cobb 500	40 to 42/4	23L:1D	1) 20L:4D 2) 16L:8D	Gait score (0)
Schwean-Lardner <i>et al</i> 2013	4 experiments: 1 day to 31-48 days Mixed Ross x Ross 308 and Ross x 708	Total ranging from 2912 to 5040/2	23L:1D	1) 20L:4D 2) 17L:7D 3) 14L: 10D	Gait score (↓) Footpad dermatitis score (↓)
Das & Lacin 2014	1 day to 42 days Males Ross 308	Not stated (total of 480)/10	24L	1) 16L:8D 2) 4L:2D	Gait scores (↓) TD score (0)
Van der Pol <i>et al</i> 2015	Experiment 1: 1 day to 4 days Mixed Ross 308 Experiment 2: 1 day to 4 days Males Ross 308	50/20	24 L	1) 2L:1D (abrupt) 2) 2L:1D (dimming) 3) 2L:6D (abrupt) 4) 2L:6D (dimming)	Experiment 1: Tibia and femur diameter (↓) Other tibia and femur properties (0) Experiment 2: Femur diameter (↓) Other tibia and femur properties (0)

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Table 3 Summary of research on the effect of stocking density on leg health in broilers (page 2 of 2)

Study	Population Age Sex Breed	Group size (N) <sup>1</sup> / replications per treatment	High stocking density (Comparator)	Low stocking density (Exposure)	Outcome and the effect of exposure indicated as (↓) <sup>2</sup> ,(↑) <sup>3</sup> or (0) <sup>4</sup> .
Ventura <i>et al</i> 2010	1 day to 9 weeks Mixed Ross 308	36 to 80/4	18 birds/m <sup>2</sup>	1) 13 birds/m <sup>2</sup> 2) 8 birds/m <sup>2</sup>	Hock burn score (↓) Footpad dermatitis score (↓)
Skrbic <i>et al</i> 2011	1 day to 42 days Males Hubbard	Not stated (total of 1380)/4	20 birds/m <sup>2</sup>	1) 15 birds/m <sup>2</sup> 2) 10 birds/m <sup>2</sup>	Gait score (0) Hock burn score (0) Footpad lesion score (↓)
Zuowei <i>et al</i> 2011	1 day to 42 days Mixed Ross 308	30 to 49/6	Males: 16 birds/m <sup>2</sup> Females: 18 birds/m <sup>2</sup>	Males: 10 birds/m <sup>2</sup> Females: 12 birds/m <sup>2</sup>	Gait score (↓) Footpad burn score (↓)
Buijs <i>et al</i> 2012	1 day to 39 days Mixed Ross 308	8 to 72/4	1) 13,6 birds/m <sup>2</sup> 2) 15,5 birds/m <sup>2</sup> 3) 18,5 birds/m <sup>2</sup> 4) 21,8 birds/m <sup>2</sup>	1) 12,1 birds/m <sup>2</sup> 2) 8,8 birds/m <sup>2</sup> 3) 5,8 birds/m <sup>2</sup> 4) 2,4 birds/m <sup>2</sup>	TD score (0) Tibia length (↑) Tibia strength (↑) Other tibia measures (0) Femur measures (0)
Knierum 2013	1 day - 40 days Mixed Lohmann	18 to 42/3	1) 40 kg/m <sup>2</sup> 2) 35 kg/m <sup>2</sup>	1) 25 kg/m <sup>2</sup> 2) 18 kg/m <sup>2</sup>	Gait score (↓) Footpad lesion score (↓)
Hongchao <i>et al</i> 2013	1 day to 5 weeks Mixed Arbor Acres	48 to 80/3 replicates per treatment	20 birds/m <sup>2</sup>	1) 16 birds/m <sup>2</sup> 2) 12 birds/m <sup>2</sup>	Gait score (0) Hock burn score (↓) Footpad burn score (↓)
Das & Lacin 2014	1 day to 42 days Males Ross 308	Not stated (total of 480)/10	20 birds/m <sup>2</sup>	12 birds/m <sup>2</sup>	Gait score (0) TD score (0)

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